AKSHAYANANDA BOSE

(14 June 1911 – 12 April 1997)

Biog. Mem. Fell. INSA, New Delhi **36** 1-10 (2009)

A. Bose

AKSHAYANANDA BOSE

(1911–1997)

Elected Fellow 1957

AKSHAYANANDA BOSE was born on June 14, 1911 in Dacca, East Bengal (now Bangladesh) in an educated and cultured family. His father, Ramesh Charan Bose was a school teacher, a good painter, and an ardent gardener (a quality which influenced young Akshayananda and remained a great passion throughout his life). Akshayananda's mother, Hem Nalini, who died prematurely at the age of 39, was a loving person and well-versed in Bengali and Sanskrit literature. She possessed good poetic and musical talents. Akshayananda's maternal and paternal uncles were highly educated and well placed in society. Two of his maternal uncles were Professors at Dacca University, and another one was a Member of Legislative Council of Assam. One of his paternal uncles was an eminent scholar of several languages, and Reader at Dacca University. The scholarly and cultured family background influenced Akshayananda profoundly in his life.

Akshayananda spent his childhood with his mother in Dacca, but it was felt that his education was not going well. He was, therefore, shifted to Sumanganj at the age of 10, and admitted to Jubilee High School where his father was also a teacher. Akshayananda worked hard, and was soon able to make up for the lost years of studies. He passed his Matriculation Examination in 1927 in first class with high marks, and won a government scholarship. He then joined Dacca Intermediate College, and passed ISc examination in 1929 in first class with high position, and was awarded a University Merit scholarship. Akshayananda joined Dacca University for BSc (Hons) course in Physics, with mathematics and chemistry as subsidiary subjects. Dacca University in those days was a centre of academic excellence and had on its faculty a galaxy of illustrious scientists, scholars, and teachers consisting of persons like Professors SN Bose, KS Krishnan, JC Ghosh, NM Bose, SR Khasagir, and many others. The academic atmosphere on the campus was electrifying and stimulating for students and young faculty. Akshayananda came in close contact, particularly with Professors SN Bose and KS Krishnan, which greatly inspired him, and had a lasting influence on him.

Akshayananda passed the BSc (Hons) in 1932 in first class standing first in the University and was awarded the prestigious Raja Kalinarayan Scholarship. However, just before the results were declared his mother passed away after prolonged illness. This saddened him greatly and created an emptiness in his life. He was however soon able to overcome the grief, and move ahead with his

postgraduate studies. He continued at Dacca University for his MSc and opted a mixed course with thesis under the guidance of Professor KS Krishnan. The topic of his thesis was magnetic studies on diamagnetic compounds. This was indeed the first time that he was introduced to research in magnetism, which became his lifelong academic pursuit. He passed MSc in 1933 in first class, and decided to do his doctoral work with Professor Krishnan. About the same time Professor Krishnan took up a Chair Professorship at the Indian Association for the Cultivation of Science (IACS), Calcutta. IACS in those days was located in the centre of the city at 210 Bow Bazar Street, an address that had already become internationally famous largely due to Professor CV Raman.

DOCTORAL PERIOD AND MANY INTERRUPTIONS

When Akshayananda joined IACS, the research work in Krishnan's laboratory was mainly done on diamagnetic and paramagnetic systems. Akshayananda chose to work on the magnetic properties of iron group of paramagnetic compounds in single crystal form. The main aim of the studies on paramagnetic compounds in those days was to examine the validity and applicability of the newly proposed crystal field theories of Van Vleck, Penney and Sclapp. A large amount of experimental data had already been obtained by his senior colleagues for this purpose, but these data were only at room temperature. Akshayananda realized that a proper assessment of the theories was not possible in the absence of data over a wide range of temperatures, especially at lower temperatures. He therefore designed and constructed a variable temperature cryostat using liquid oxygen as refrigerant and incorporated it with single crystal magnetic susceptibility and anisotropy instruments, which operated between room temperature and 90K. An automatic temperature controller system was also constructed to maintain intermediate temperatures in this range. This was the first low temperature cryostat constructed in India and one of the very few in the world at that time. When his work was going on in full swing, Akshayananda fell seriously ill with pleurisy, and it took him about a year to recover fully.

Using these facilities Akshayananda studied extensively the temperature dependence of magnetic susceptibility and anisotropy of paramagnetic compounds of iron group and examined the results against the existing theories. This was indeed the first definitive experimental verification of the crystal field theory of Van Vleck and others. When the work was nearing completion, and the writing of the thesis was about to begin, he was stuck with a dreaded disease, kala-azar. He was fortunate to recover from it. In the mean time in 1938, his scholarship was over, and he had to take up a full time teaching job at St Edmonds College in Shillong and leave the thesis work incomplete. He worked in Shillong for over 3 years, and used to come over to IACS during summer vacations to carry out the pending thesis work. In January 1942 Professor Krishnan offered him a Research Assistantship under him. He immediately joined IACS with great hopes but these were shattered

when he found, on his arrival at the IACS, that all instruments and books of the laboratories had been packed and moved from the Bow Bazaar Street building to a different location for fear of impending bombing of Calcutta (this was the Second World War period). In the very next month Professor Krishnan left IACS to take up a Professorship at Allahabad University. Being Krishnan's research assistant and the fact that there was no possibility of carrying out any work at IACS, Akshayananda also moved to Allahabad University. He was finally able to complete his thesis there and submit it to Dacca University in 1943. In the mean time his research assistantship was over, and he had to take up again a teaching job at Jagannath College, Dacca. In 1945 he was awarded the DSc Degree by the Dacca University. These long and repeated periods of being away from active research was very frustrating, and he looked forward to better times with his characteristic optimism. The opportunity came in 1947 when he was offered a position of Research Officer in the Department of X ray, Magnetism and General Physics at IACS, Calcutta.

RESEARCH ACTIVITIES AND PROFESSIONAL CAREER AT IACS

Akshayananda was happy to return to active research career after a lapse of about 10 years. The laboratories at IACS were however lying in disarray after the dislocation due to the Second World War. Lot of changes had also taken place in the structure of the institute in the interim period. Around 1950-51, IACS was shifted to its present site in Jadavpur. Akshayananda soon got busy in developing the low temperature and magnetism laboratory. He revived his old interest in cryogenics and proposed the design and fabrication of a multistage low-speed turbo-expander gas liquefier which could also be used for liquefaction of gases for industrial purposes. The concept was theoretically sound but did not receive favourable response from the funding agencies, and had to be abandoned. A short paper of the concept was however published in 1949. Persisting with his zeal in developing cryogenic facilities in India, Akshayananda finally designed and constructed in 1952 a metal helium liquefier-cum-cryostat where magnetic and electrical measurements could be done down to 20K. He did the entire construction and testing work at the workshop of IACS. This was the first time that helium gas was liquefied in India, and the feat was greatly appreciated. Around the same time he was appointed to the position of Reader at IACS.

Along with the developments in low temperature facilities, Akshayananda continued with his research interest in crystal magnetism of iron group of compounds. He addressed to fundamental issues in crystal paramagnetism such as effects of Jahn–Teller distortions in the ground and excited electronic states, spin-orbit coupling interaction, steriochemical variations around the metal ions, and the outer-sphere interactions, on the magnetic properties of such compounds. Newer experimental techniques were devised and instruments fabricated for magnetic measurements with higher sensitivity. More accurate control of temperatures was

also achieved in modified cryostats. These measurements provided a platform for further developments in crystal field theory. Around middle of 1950s, MHL Pryce and his colleagues developed a new spin Hamiltonian formalism, which was successful in the interpretation of the Electron Spin Resonance (ESR) results of iron group compounds. The formalism considered only the ground electronic states of the metal ions. This was adequate for the ESR results, since these measurements are generally carried out at very low temperatures when only the ground state would be thermally populated. The theory was obviously not adequate for magnetic susceptibility and anisotropy results, in which case the measurements are usually carried out from room to very low temperatures, and hence besides the ground states many exited states would also be thermally populated. Akshayananda and his colleagues modified this theory and proposed a model which considered the effects of ground and excited electronic states of the metal ions through spin orbit coupling, and included the effects of orbital angular momentum. The modified theory was used in the analysis of the magnetic results, which provided a comprehensive rationalization of the crystal field theory and brought into focus several new features. This was an exciting period of the laboratory, and the present author was privileged to play a small role during this period as a research student.

In between this period, Akshayananda was invited in 1953 to spend three months at NPL, New Delhi to collaborate with Professor D Shoenberg (of Clarendon Laboratory, Oxford) in setting up magnetic instruments for magnetic saturation studies at liquid helium temperatures and high magnetic fields. The instruments were set up and the measurements were made in a very short time. The results turned out to be very interesting, and were jointly published in the Transaction of Bose Research Institute. During 1956-57, Akshayananda spent one year on sabbatical leave at Clarendon Laboratory, Oxford to learn about the then emerging new technique of ESR. In 1956 he was invited to lecture at the First International Conference on Magnetism in Moscow. The same year Akshayananda was appointed as Professor of Physics at IACS, and was made Head of the newly created Department of Magnetism. He was elected to the Fellowship of INSA in 1957.

Akshayananda retired from IACS in 1976, but kept his association with it as Emeritus Professor. During his long research career he published large number of papers, in reputed journals. It should be mentioned that he often encouraged his students and younger colleagues in the lab to publish papers independently, and he put his name in the papers only when his contribution was significant. The list of his papers is given at the end in the Bibliography.

DEVELOPMENT OF CRYOGENIC TECHNOLOGY AND INDIAN CRYOGENIC COUNCIL

As mentioned earlier, Akshayananda possessed an intense interest in Cryogenics right from his early years in research. During his doctoral work he constructed a

variable temperature liquid oxygen cryostat. Subsequently he got interested in the turbo- expander liquefier, and finally in 1954 he designed and constructed the first helium liquefier-cum-cryostat in India. After his retirement, he devoted full time to the development and application of cryogenic technology in the country. With the support of National Committee of the International Institute of Refrigeration, he set up Indian Cryogenic Council (ICC). The main objective of ICC was to bring on common platform cryogenic experts of India and other countries for the development of cryogenic technology in India, and to promote collaboration between the academia and industries. Akshayananda was elected as President of ICC and later its Honorary Director General. With renewed enthusiasm he plunged into the development of this venture, and soon set up its branches in different parts of the country. An R & D institute, Advanced Centre of Cryogenic Research (ACCR), was set up on the campus of Jadavpur University, Calcutta. Research and development projects such as cryothermometer, cryogen container, surgical cryoprobe, food preservation at low temperatures and many other biological applications were taken up at ACCR. Akshayananda also started a research journal, Indian Journal of Cryogenics, and took up the charge of its editorship, which he carried out almost to his last days.

AWARDS AND RECOGNITIONS

The research work of Professor Akshayananda Bose in magnetism and cryogenics was widely recognized. Some of the recognitions he received have been mentioned earlier in the text. Besides the INSA Fellowship he also served on its Council during 1976-78, and received INSA Senior Scientist Medal in 1985. He was awarded Raman Birth Centenary Medal by Indian Academy of Science in 1988. In 1991 West Bengal Academy of Science and Technology felicitated him on his 80th birthday. He was on the Advisory Board/Council of IIT Kharagpur, NPL, Fertilizer Corporation of India, Sindri, and many others. He had been invited to many conferences in India and abroad to present his research work. He had lectured/ Chaired at the International conferences in Magnetism held in Moscow, Nottingham, and Boston. He delivered KS Krishnan Memorial Lectures on different occasions. He was a Member of IUAPAC, and was nominated as Member of International Institute of Refrigeration.

MARRIAGE AND FAMILY

Akshayananda married Chameli in 1942 in Dacca, who was the daughter of Satis Chandra Roy, a renowned lawyer in Dacca in those days. Chameli Bose had done BA (Hons) in English from Dacca University and a certificate course in English in Oxford. She taught in a Calcutta school with distinction, and retired in 1987. She now leads a peaceful life in her home in Calcutta. Akshayananda and Chameli have two daughters and a son. Their eldest daughter, Dr (Mrs) Malini Bhattacharya was educated in Calcutta and UK, and was Professor of English at Jadavpur University.

She has also been keenly involved in public life, and social activities. Their second daughter, Dr (Mrs) Ketaki Bhattacharya is a Fellow of Royal College of Anaesthetists, and is a well known anaesthetist in Kolkata. Their son, Dr Kumardev Bose did his PhD from Jadavpur University and is working with Chloride India Limited.

CONCLUDING REMARKS

Akshayananda was a kind, gentle and loving person. He had a charming and impressing personality, which exuded confidence, his optimistic frame of mind and tenacity of purpose. His fatherly love and encouragement for the students were a great source of inspiration to them, particularly during their difficult times. Akshayananda was a voracious reader and would not mind reading any kind of books, including even children's books. His major hobby was, of course, gardening, which he inherited from his father. He was particularly interested in the cultivation of roses and had grown as many as 100 exotic varieties in his garden.

Akshayananda's life spanned over eight decades, during which large changes occurred in the country and all over the world. He felt the adverse effects of Second World War during his doctoral period, when his research work was hampered very badly. He witnessed the freedom struggle movement, and the advent of independence of the country. However the agony of the partition of the country severely affected him and his family like millions of others in the region. He took all these in a philosophical manner and moved forward. Akshayananda had a good health for the most part of his life except for brief periods of illness during the early years. It is therefore sad that he suffered a great deal during the last 3-4 years of his life due to leukaemia. He battled bravely with this disease, and used to visit ACCR very often even during his illness, and plan future course of projects at the Centre. He finally succumbed to the disease and passed away on 12 April 1997.

ACKNOWLEDGEMENTS

The author expresses his thanks to Mrs. Chameli Bose for providing materials and information about Professor Bose. He is also indebted to her for her kind hospitality during his visit at her house.

Residence:
Panchami 508 Udita
1051/1, Survey Park
Kolkata-700075 (WB)
Mobile: 09831273257

SAMARESH MITRA
Formerly at Tata Institute of Fundamental Research, Mumbai
Currently at Indian Institute of Chemical Biology, Kolkata
E-mail: mitrasamaresh@yahoo.com

BIBLIOGRAPHY

1935 Weiss constant of paramagnetic ions in the S state Part I *Proc Ind Acad Sci* **1** 605

– Part II *Proc Ind Acad Sci* **1** 754

– Magnetic susceptibility of organic substances in different physical states *Phil Mag* **21** 1119

1938 (With KRISHNAN KS) Coupling between the orbital and the spin angular momenta of paramagnetic ions from magnetic measurements *Nature* **141** 329

1939 (With KRISHNAN KS and MOOKHERJEE A) Investigations on magnetocrystalline action Part VI *Phil Trans Roy Soc* **A238** 125

1947 A new cryostat of the gas flow type and a quartz fibre microbalance for magneto-crystalline measurements *Ind J Phys* **21** 74

1948 Changes in the orientations of the principal magnetic axes of single crystal of the iron group of salts with variation of temperature *Ind J Phys* **22** 74

– Paramagnetism of single crystals of the salts of the iron group of elements at low temperatures Part I *Ind J Phys* **22** 195

– Part II *Ind J Phys* **22** 276

– Part III *Ind J Phys* **23** 483

1949 A multistage turbo-expander air liquefier *Ind J Phys* **23** 433

1952 (With MITRA SC) Comparative influence of short and long range crystalline electric fields on the magnetic behaviour of the salts of iron group of elements Part I *Ind J Phys* **26** 393

– Part II *Ind J Phys* **26** 543

– Part III *Ind J Phys* **27** 95

– (With SHOENBERG D) Some experiments on magnetic salts *Trans Bose Res Inst* **20**

– (With DUTTA AK) A new economic type hydrogen liquefier *J Sci Industrial Research* **14B** 377

1957 (MITRA SC and DUTTA SK) The behaviour of paramagnetic ion in the single crystals of some similar salts of the iron group of elements: Hydrated cupric salts Part I *Proc Roy Soc London* **A239** 165

– The effect of long range crystalline electric fields on the magnetic anisotropy of the salts of Cu (II) and Ni (II) Magnetism: Report of the Symposium IACS

– Paramagnetic properties of some salts of the iron group of elements *Izvest Akad Nauk USSR Ser Fiz* **21** 802

1958 (With MITRA SC and DUTTA SK) The behaviour of paramagnetic ion in some crystalline salts of the iron group of elements Hydrated Ni (II) salts Part II *Proc Roy Soc London* **A248** 53

1959 (With DUTTA SK Roy CHAKRAVORTY AS) Studies on the magnetic susceptibility of V (III) and Ti (III) alums in the range 300K to 100K *Ind J Phys* **33** 483

– A gas flow cryostat in the range of temperature 400K to 20K Proc Int Measurements Conf Budapest

– Paramagnetic behaviour of some salts of iron group of elements *Bull Inst Sci India* **14** 36

– (With CHAKRAVORTY AS and CHATTERJEE R) Magnetic behaviour of titanium cesium sulphate alum *Ind J Phys* **33** 325

1960 (With CHAKRAVORTY AS and CHATTERJEE R) The nature of crystalline fields in Ti (III) alum *Proc Roy Soc London* **A255** 145

1961 (With CHAKRAVORTY AS and CHATTERJEE R) Paramagnetic behaviour of hydrated Co (II) salts *Proc Roy Soc London* **A261** 43

1961 (With CHAKRAVORTY AS and CHATTERJEE R) Nature of crystalline fields in hydrated iron (II) salts *Ind J Phys* **36** 207

– (With CHAKRAVORTY AS and CHATTERJEE R) Nature of crystalline fields in hydrated iron (II) salts *Proc Roy Soc London* **A261** 207

1962 (With CHAKRAVORTY AS, CHATTERJEE R and DUTTA ROY SK) Paramagnetic behaviour of the hydrated salts of Ti(III) V(III) Fe(II) and Co(II) *J Phys Soc Japan* **17**

1963 (With DUTTA ROY SK GHOSH PK and MITRA S) An electrodynamic balance and a new liquid oxygen cryostat for measuring magnetic susceptibilities between 400K and 60K *Ind J Phys* **37** 505

– (With DUTTA ROY SK) A new liquid oxygen cryostat *Ind J Phys* **37** 505

1964 (With CHATTERJEE R and RAI R) Molecular orbital theory of ligand field in hydrated (VII) salts *Proc Phys Soc London* **83** 361

– (With GHOSH US, PAL AK and BAGCHI RN) Principal values of magnetic complex Cu(II) 6 H2O in crystals *Ind J Phys* **38** 361

1965 (With JACKSON LC and RAI R) Ligand field theory of magnetic susceptibility and anisotropy in tetrahedrally distorted Co(II) complexes *Ind J Phys* **39** 7

– (With RAI R) Ligand field theory of susceptibility and anisotropy in tetrahedrally distorted Fe(II) complexes *Ind J Phys* **39** 176

– (With MITRA S and RAI R) Magnetic studies of single crystals containing tetrahedrally coordinated Cu(II) and Co(II) ions between 300K and 90K *Ind J Phys* **39** 357

– (With RAI R and MITRA S) Molecular orbital theory of the ligand field in Ni(II) complexes *Ind J Phys* **39** 318

– (With LAHIRI S and GHOSH US) Ligand field theory of the magnetic of tetrahedrally coordinated Cu(II) ions in Cs_2CuCl_4 *J Phys Chem Solid* **26** 747

1966 (With RAI R MITRA S and KUMAR S) On the magnetic and optical behaviour of $CoCs_3Cl_5$ *Physica* **32** 1966

1969 (With GHOSH US) Dependence of ligand field in paramagnetic crystals on thermal changes in their structures *Radiation Effects* **4** 275

1974 (With STHANAPATI J GHOSHAL AK PAL D and PAL AK) A simple inexpensive cryogenic liquid controller *Cryogenics* **14** 477

1976 (With BOSE PK) Problems and possibilities in the use of cryogenic temperatures in man *Ind J cryogenics* **1** 22

– Forty years of cryogenic research at IACS Calcutta *Ind J Cryogenics* **1** 75

– NBS Cryogenics Division at Boulder *Ind J Cryogenics* **1** 83

1976 Indian Cryogenics Council looks forward *Ind J Cryogenics* **3** 159

1978 (With PAL AK, PAL D, GHOSHAL AK, STHANPATI J, MAITI CR and DEY DK) Temperature controllers for cryogenic applications *Ind J Cryogenics* **3** 292

1979 Application of cryogenic technology in the development of rural areas Proc of Seminar on Appropriate Technology for Development **17**

1980 Cryogenic age has come to India *Ind J Cryogenics* **5** 19

1989 (With SARKAR SC and SARKAR A) A new design of all stainless cryogen vessel of capacities of 2-25 litres *Ind J Cryogenics* **5**

1993 (With SARKAR SC) The design of a cryogenic wheel valve for operation at liquid hydrogen temperature and test for leakage *J Metals & fuels* **65**